CHAPTER 1
INTRODUCTION TO FMECA

1-1. Purpose

The purpose of this manual is to guide facility managers through the Failure Mode, Effects and Criticality Analysis (FMECA) process, directing them how to apply this type of analysis to a command, control, communications, computer, intelligence, surveillance, and reconnaissance (C4ISR) facility. These facilities incorporate several redundant systems used to achieve extremely high availability that require specialized tools, which are described in this manual, to conduct an accurate analysis.

1-2. Scope

The information in this manual will provide the facility manager the necessary tools needed to conduct a realistic approach to establish a relative ranking of equipments' effects on the overall system. The methods used in this manual have been developed using existing concepts from various areas. These methods include an easy to use evaluation method to address redundancy's affect on failure rates and probability of occurrence. Because a C4ISR facility utilizes numerous redundant systems this method is very useful for conducting a FMECA of a C4ISR facility. Examples will be provided to illustrate how this can be accomplished by quantitative (with data) or qualitative means (without data). Although heating, ventilation and air conditioning (HVAC) systems are used as examples, the FMECA process can be applied to any electrical or mechanical system.

1-3. References

Appendix A contains a list of references used in this manual. Prescribed forms are also listed in appendix A. These five forms may be found on the Army Printing Directorate (APD) website http://www.apd.army.mil/.

1-4. Define FMECA

The FMECA is composed of two separate analyses, the Failure Mode and Effects Analysis (FMEA) and the Criticality Analysis (CA). The FMEA analyzes different failure modes and their effects on the system while the CA classifies or prioritizes their level of importance based on failure rate and severity of the effect of failure. The ranking process of the CA can be accomplished by utilizing existing failure data or by a subjective ranking procedure conducted by a team of people with an understanding of the system. Although the analysis can be applied to any type of system, this manual will focus on applying the analysis to a C4ISR facility

a. The FMECA should be initiated as soon as preliminary design information is available. The FMECA is a living document that is not only beneficial when used during the design phase but also during system use. As more information on the system is available the analysis should be updated in order to provide the most benefit. This document will be the baseline for safety analysis, maintainability, maintenance plan analysis, and for failure detection and isolation of subsystem design. Although cost should not be the main objective of this analysis, it typically does result in an overall reduction in cost to operate and maintain the facility

1-5. History

The FMECA was originally developed by the National Aeronautics and Space Administration (NASA) to improve and verify the reliability of space program hardware. The cancelled MIL-STD-785B, entitled *Reliability Program for System and Equipment Development and Production*, Task 204, *Failure Mode, Effects and Criticality Analysis* calls out the procedures for performing a FMECA on equipment or systems. The cancelled MIL-STD-1629A is the military standard that establishes requirements and procedures for performing a FMECA, to evaluate and document, by failure mode analysis, the potential impact of each functional or hardware failure on mission success, personnel and system safety, maintainability and system performance. Each potential failure is ranked by the severity of its effect so that corrective actions may be taken to eliminate or control design risk. High risk items are those items whose failure would jeopardize the mission or endanger personnel. The techniques presented in this standard may be applied to any electrical or mechanical equipment or system. Although MIL-STD-1629A has been cancelled, its concepts should be applied during the development phases of all critical systems and equipment whether it is military, commercial or industrial systems/products.

1-6. FMECA benefits

The FMECA will: highlight single point failures requiring corrective action; aid in developing test methods and troubleshooting techniques; provide a foundation for qualitative reliability, maintainability, safety and logistics analyses; provide estimates of system critical failure rates; provide a quantitative ranking of system and/or subsystem failure modes relative to mission importance; and identify parts & systems most likely to fail.

a. Therefore, by developing a FMECA during the design phase of a facility, the overall costs will be minimized by identifying single point failures and other areas of concern prior to construction, or manufacturing. The FMECA will also provide a baseline or a tool for troubleshooting to be used for identifying corrective actions for a given failure. This information can then be used to perform various other analyses such as a Fault Tree Analysis or a Reliability-Centered Maintenance (RCM) analysis.

b. The Fault Tree Analysis is a tool used for identifying multiple point failures; more than one condition to take place in order for a particular failure to occur. This analysis is typically conducted on areas that would cripple the mission or cause a serious injury to personnel.

c. The RCM analysis is a process that is used to identify maintenance actions that will reduce the probability of failure at the least amount of cost. This includes utilizing monitoring equipment for predicting failure and for some equipment, allowing it to run to failure. This process relies on up to date operating performance data compiled from a computerized maintenance system. This data is then plugged into a FMECA to rank and identify the failure modes of concern.

d. For more information regarding these types of analyses refer to the following publications:

(1) Ned H. Criscimagna, *Practical Application of Reliability Centered Maintenance* Report No. RCM, Reliability Analysis Center, 201 Mill Street, Rome, NY, 2001.

(2) David Mahar, James W. Wilbur, *Fault Tree Analysis Application Guide*, Report No. FTA, Reliability Analysis Center, 201 Mill St., Rome, NY: 1990

(3) *NASA's Reliability Centered Maintenance Guide for Facilities and Collateral Equipment*, February 2000.

1-7. Team effort

The FMECA should be a catalyst to stimulate ideas between the design engineer, operations manager, maintenance manager, and a representative of the maintenance personnel (technician). The team members should have a thorough understanding of the systems operations and the mission's requirements. A team leader should be selected that has FMECA experience. If the leader does not have experience, then a FMECA facilitator should be sought. If the original group of team members discovers that they do not have expertise in a particular area during the FMECA then they should consult an individual who has the knowledge in the required area before moving on to the next phase. The earlier a problem in the design process is resolved, the less costly it is to correct it.

1-8. FMECA characteristics

The FMECA should be scheduled and completed concurrently as an integral part of the design process. Ideally this analysis should begin early in the conceptual phase of a design, when the design criteria, mission requirements and performance parameters are being developed. To be effective, the final design should reflect and incorporate the analysis results and recommendations. However, it is not uncommon to initiate a FMECA after the system is built in order to assess existing risks using this systematic approach. Figure 1-1 depicts how the FMECA process should coincide with a facility development process.

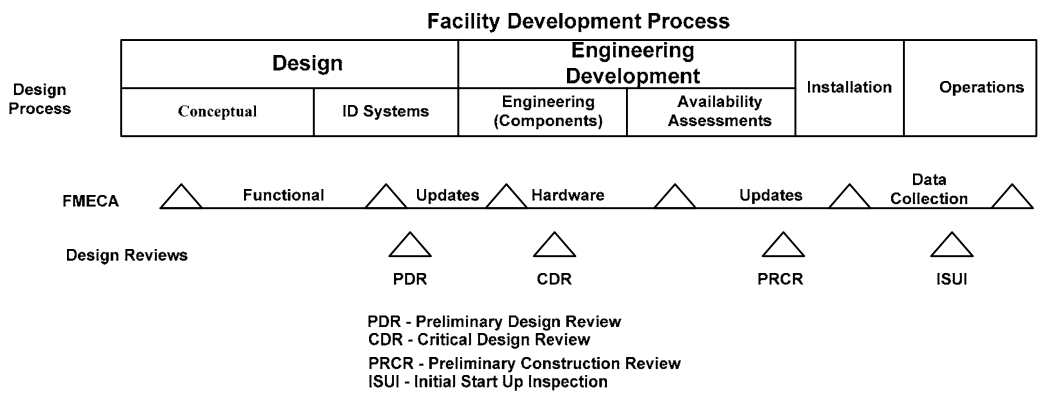

Figure 1-1. Facility development process

Since the FMECA is used to support maintainability, safety and logistics analyses, it is important to coordinate the analysis to prevent duplication of effort within the same program. The FMECA is an iterative process. As the design becomes mature, the FMECA must reflect the additional detail. When changes are made to the design, the FMECA must be performed on the redesigned sections. This ensures that the potential failure modes of the revised components will be addressed. The FMECA then becomes an important continuous improvement tool for making program decisions regarding trade-offs affecting design integrity.